GE Medical Systems

Technical Publications

Direction 2196272−100

Revision 1

High Voltage Cable Installation and TroubleshootingProcedures

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Operating Documentation

WARNING

- **THIS SERVICE MANUAL IS AVAILABLE IN ENGLISH ONLY.**
- **IF A CUSTOMER'S SERVICE PROVIDER REQUIRES A LANGUAGE OTHER THAN ENGLISH, IT IS THE CUSTOMER'S RESPONSIBILITY TO PROVIDE TRANSLATION SERVICES.**
- **DO NOT ATTEMPT TO SERVICE THE EQUIPMENT UNLESS THIS SERVICE MANUAL HAS BEEN CONSULTED AND IS UNDERSTOOD.**
- **FAILURE TO HEED THIS WARNING MAY RESULT IN INJURY TO THE SERVICE PROVIDER, OPERATOR OR PATIENT FROM ELECTRIC SHOCK, MECHANICAL OR OTHER HAZARDS.**

AVERTISSEMENT

- **CE MANUEL DE MAINTENANCE N'EST DISPONIBLE QU'EN ANGLAIS.**
- **SI LE TECHNICIEN DU CLIENT A BESOIN DE CE MANUEL DANS UNE AUTRE LANGUE QUE L'ANGLAIS, C'EST AU CLIENT QU'IL INCOMBE DE LE FAIRE TRADUIRE.**
- **NE PAS TENTER D'INTERVENTION SUR LES ÉQUIPEMENTS TANT QUE LE MANUEL SERVICE N'A PAS ÉTÉ CONSULTÉ ET COMPRIS.**
- **LE NON-RESPECT DE CET AVERTISSEMENT PEUT ENTRAÎNER CHEZ LE TECHNICIEN, L'OPÉRATEUR OU LE PATIENT DES BLESSURES DUES À DES DANGERS ÉLECTRIQUES, MÉCANIQUES OU AUTRES.**

WARNUNG

- **DIESES KUNDENDIENST–HANDBUCH EXISTIERT NUR IN ENGLISCHER SPRACHE.**
- **FALLS EIN FREMDER KUNDENDIENST EINE ANDERE SPRACHE BENÖTIGT, IST ES AUFGABE DES KUNDEN FÜR EINE ENTSPRECHENDE ÜBERSETZUNG ZU SORGEN.**
- **VERSUCHEN SIE NICHT, DAS GERÄT ZU REPARIEREN, BEVOR DIESES KUNDENDIENST–HANDBUCH NICHT ZU RATE GEZOGEN UND VERSTANDEN WURDE.**
- **WIRD DIESE WARNUNG NICHT BEACHTET, SO KANN ES ZU VERLETZUNGEN DES KUNDENDIENSTTECHNIKERS, DES BEDIENERS ODER DES PATIENTEN DURCH ELEKTRISCHE SCHLÄGE, MECHANISCHE ODER SONSTIGE GEFAHREN KOMMEN.**

AVISO

- **ESTE MANUAL DE SERVICIO SÓLO EXISTE EN INGLÉS.**
- **SI ALGÚN PROVEEDOR DE SERVICIOS AJENO A GEMS SOLICITA UN IDIOMA QUE NO SEA EL INGLÉS, ES RESPONSABILIDAD DEL CLIENTE OFRECER UN SERVICIO DE TRADUCCIÓN.**
- **NO SE DEBERÁ DAR SERVICIO TÉCNICO AL EQUIPO, SIN HABER CONSULTADO Y COMPRENDIDO ESTE MANUAL DE SERVICIO.**
- **LA NO OBSERVANCIA DEL PRESENTE AVISO PUEDE DAR LUGAR A QUE EL PROVEEDOR DE SERVICIOS, EL OPERADOR O EL PACIENTE SUFRAN LESIONES PROVOCADAS POR CAUSAS ELÉCTRICAS, MECÁNICAS O DE OTRA NATURALEZA.**

ATENÇÃO

- **ESTE MANUAL DE ASSISTÊNCIA TÉCNICA SÓ SE ENCONTRA DISPONÍVEL EM INGLÊS.**
- **SE QUALQUER OUTRO SERVIÇO DE ASSISTÊNCIA TÉCNICA, QUE NÃO A GEMS, SOLICITAR ESTES MANUAIS NOUTRO IDIOMA, É DA RESPONSABILIDADE DO CLIENTE FORNECER OS SERVIÇOS DE TRADUÇÃO.**
- **NÃO TENTE REPARAR O EQUIPAMENTO SEM TER CONSULTADO E COMPREENDIDO ESTE MANUAL DE ASSISTÊNCIA TÉCNICA.**
- **O NÃO CUMPRIMENTO DESTE AVISO PODE POR EM PERIGO A SEGURANÇA DO TÉCNICO, OPERADOR OU PACIENTE DEVIDO A' CHOQUES ELÉTRICOS, MECÂNICOS OU OUTROS.**

AVVERTENZA

- **IL PRESENTE MANUALE DI MANUTENZIONE È DISPONIBILE SOLTANTO IN INGLESE.**
- **SE UN ADDETTO ALLA MANUTENZIONE ESTERNO ALLA GEMS RICHIEDE IL MANUALE IN UNA LINGUA DIVERSA, IL CLIENTE È TENUTO A PROVVEDERE DIRETTAMENTE ALLA TRADUZIONE.**
- **SI PROCEDA ALLA MANUTENZIONE DELL'APPARECCHIATURA SOLO DOPO AVER CONSULTATO IL PRESENTE MANUALE ED AVERNE COMPRESO IL CONTENUTO.**
- **NON TENERE CONTO DELLA PRESENTE AVVERTENZA POTREBBE FAR COMPIERE OPERAZIONI DA CUI DERIVINO LESIONI ALL'ADDETTO ALLA MANUTENZIONE, ALL'UTILIZZATORE ED AL PAZIENTE PER FOLGORAZIONE ELETTRICA, PER URTI MECCANICI OD ALTRI RISCHI.**

警告

・このサービスマニュアルには英語版しかありません。
・ＧＥＭＳ以外でサービスを担当される業者が英語以外の言語を要求される場合、翻訳作業はその業者の責任で行うものとさせていただきます。
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注意:

- 本维修手册仅存有英文本。
- 非 GEMS 公司的维修员要求非英文本的维修手册时，客户需自行负责翻译。
- 未详细阅读和完全了解本手册之前，不得进行维修。
- 忽略本注意事项会对维修员，操作员或病人造成触电，机械伤害或其他伤害。

Direction 2196272–100

Revision 1

High Voltage Cable Installation and Troubleshooting Procedures

IMPORTANT! . . . X-RAY PROTECTION

X-ray equipment if not properly used may cause injury. Accordingly, the instructions herein contained should be thoroughly read and understood by everyone who will use the equipment before you attempt to place this equipment in operation. The General Electric Company, Medical Systems Group, will be glad to assist and cooperate in placing this equipment in use.

Although this apparatus incorporates a high degree of protection against x-radiation other than the useful beam, no practical design of equipment can provide complete protection. Nor can any practical design compel the operator to take adequate precautions to prevent the possibility of any persons carelessly exposing themselves or others to radiation.

It is important that everyone having anything to do with x-radiation be properly trained and fully acquainted with the recommendations of the National Council on Radiation Protection and Measurements as published in NCRP Reports available from NCRP Publications, 7910 Woodmont Avenue, Room 1016, Bethesda, Maryland 20814, and of the International Commission on Radiation Protection, and take adequate steps to protect against injury.

The equipment is sold with the understanding that the General Electric Company, Medical Systems Group, its agents, and representatives have no responsibility for injury or damage which may result from improper use of the equipment.

Various protective material and devices are available. It is urged that such materials or devices be used.

CAUTION: United States Federal law restricts this device to use by or on the order of a physician.

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If you have any comments, suggestions or corrections to the information in this document, please write them down, include the document title and document number, and send them to:

GENERAL ELECTRIC COMPANY
MEDICAL SYSTEMS

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MILWAUKEE, WI 53201–0414

CERTIFIED ELECTRICAL CONTRACTOR STATEMENT

All electrical installations that are preliminary to positioning of the equipment at the site prepared for the equipment shall be performed by licensed electrical contractors. In addition, electrical feeds into the Power Distribution Unit shall be performed by licensed electrical contractors. Other connections between pieces of electrical equipment, calibrations, and testing shall be performed by qualified GE Medical personnel. The products involved (and the accompanying electrical installations) are highly sophisticated, and special engineering competence is required. In performing all electrical work on these products, GE will use its own specially trained field engineers. All of GE's electrical work on these products will comply with the requirements of the applicable electrical codes.

The purchaser of GE equipment shall only utilize qualified personnel (i.e., GE's field engineers, personnel of third-party service companies with equivalent training, or licensed electricians) to perform electrical servicing on the equipment.

DAMAGE IN TRANSPORTATION

All packages should be closely examined at time of delivery. If damage is apparent, have notation "**damage in shipment**" written on **all** copies of the freight or express bill **before** delivery is accepted or "signed for" by a General Electric representative or a hospital receiving agent. Whether noted or concealed, damage **MUST** be reported to the carrier **immediately** upon discovery, or in any event, within **14** days after receipt, and the contents and containers held for inspection by the carrier. A transportation company will not pay a claim for damage if an inspection is not requested within this **14** day period.

Call Traffic and Transportation, Milwaukee, WI (414) 827–3449 / 8*285–3449 **immediately** after damage is found. At this time be ready to supply name of carrier, delivery date, consignee name, freight or express bill number, item damaged and extent of damage.

Complete instructions regarding claim procedure are found in Section "S" of the Policy & Procedure Bulletins.

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REVISION HISTORY

REV	DATE	REASON FOR CHANGE
0	Aug. 15, 1997	Initial release.
1	Nov. 8, 2000	Corrected part # of spanner wrench to 46−404295G1.

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SECTION 1
GENERAL

This document defines a series of installation and hardware inspection procedures that are directed at ensuring a uniform quality level for high voltage transmission on X−Ray systems. Imperfections within the cable connections at the high voltage transformer or X−Ray tube or internal defects within the cable itself cause high voltage breakdown (arcing), intermittent filament operation, or mA drift.

A mechanically positive cable interface connection within a chemically homogeneous dielectric media is required to facilitate proper and consistent electrical power delivery to the X−Ray tube. Good intimate contact is necessary at all pin/socket connections to preclude intermittent current flow or localized high voltage arcing where significant voltage gradients exist. In addition, the connections must be completely free of air pockets, foreign matter − especially metallic compounds, or any chemicals that could alter or degrade the dielectric strength of the connection. Internal cable resistance too must be bounded and consistent to achieve proper power transmission.

SECTION 2
INSPECT HIGH VOLTAGE CABLE

1. Tape or tag the cable near the terminal according to use as either ANODE or CATHODE (C1 and C2 for Hexafocus applications) cable if it is not already marked. If not certain, perform a continuity test with either an ohm or digital volt meter (DVM).

2. Remove the protective sleeve from the cable end if it is new.

3. Remove the cable end from the receptacle, if system is not new, and visually inspect the cable for black carbon tracks or bubbles in the insulation.

4. Clean the cable end with a lint−free cloth and an alcohol solvent. Use a **different** cloth to wipe dry.

5. Inspect for cracks around the terminals at the brass ring and in the body. Twist the terminal body while holding the brass ring. The terminal should not spin relative to the brass ring. If cracks exist or if the terminal spins the cable must not be used.

6. Inspect the pins on the cable terminal. The slot on each pin must be clean over the full depth. Set/Verify that the slot width is 0.5mm using spreading tool 46−208572P44.

7. Perform high voltage cable resistance checks as indicated to verify the proper electrical characteristics for both new or installed cables. Table 1 gives these performance requirements:

TABLE 1
HIGH VOLTAGE CABLE RESISTANCE

RESISTANCE – GE HIGH VOLTAGE CABLE – 80′ (See Notes 1 & 2)				
	3–CONDUCTOR		4–CONDUCTOR	
	NEW ± 20%	LIMIT	NEW ± 20%	LIMIT
Braid–Braid	0.26 Ω	1.0 Ω	0.26 Ω	1.0 Ω
Common–Common	0.28 Ω	1.0 Ω	0.20 Ω	0.8 Ω
Braid–Braid	0.30 Ω	1.2 Ω	0.30 Ω	1.2 Ω
Braid–Braid	N/A	N/A	2.5 Ω	5.0 Ω

Note 1: Null out the DVM and probe leads or subtract their resistance since this may represent a significant portion of the reading. Remove both ends of the cable from the receptacles to ensure proper measurements.

Note 2: Correction factors to be applied to all allowable resistance values for cable lengths other than 80' as follows:

- 20′ multiply all resistance limits by 0.25
- 30′ multiply all resistance limits by 0.38
- 40′ multiply all resistance limits by 0.50
- 60′ multiply all resistance limits by 0.75
- 70′ multiply all resistance limits by 0.88
- 100′ multiply all resistance limits by 1.25
- 120′ multiply all resistance limits by 1.50

8. Inspect the high voltage cable for a broken braid (usually found at bends or cable ends). Flex the cable along it's entire length, if possible, but at least at all bends and end points and measure resistance. If either the braid is broken and/or any resistance variance exceeds ±20% during flexing the cable must not be used.

SECTION 3
VERIFY CABLE AND RECEPTACLE COMPATIBILITY

1. Remove the protective “Caplug” which seals the receptacle. Inspect the interior of the receptacle to make certain it is clean and completely free of any foreign matter. Remove any insulating compound, accumulated dust, or other foreign matter with a clean lint−free cloth and an alcohol solvent. Use a **different** cloth to wipe dry.

2. Inspect the brass inserts at the bottom. Verify that a coiled contact spring is visible in each pin socket.

3. Make a trial “dry” insertion of the cable into the receptacle to test whether the pins insert properly into the receptacle. Insert the terminal so the raised key of the cable aligns with the mating notch in the receptacle. DO NOT FORCE.

4. Withdraw the terminal and recheck the cable pins.

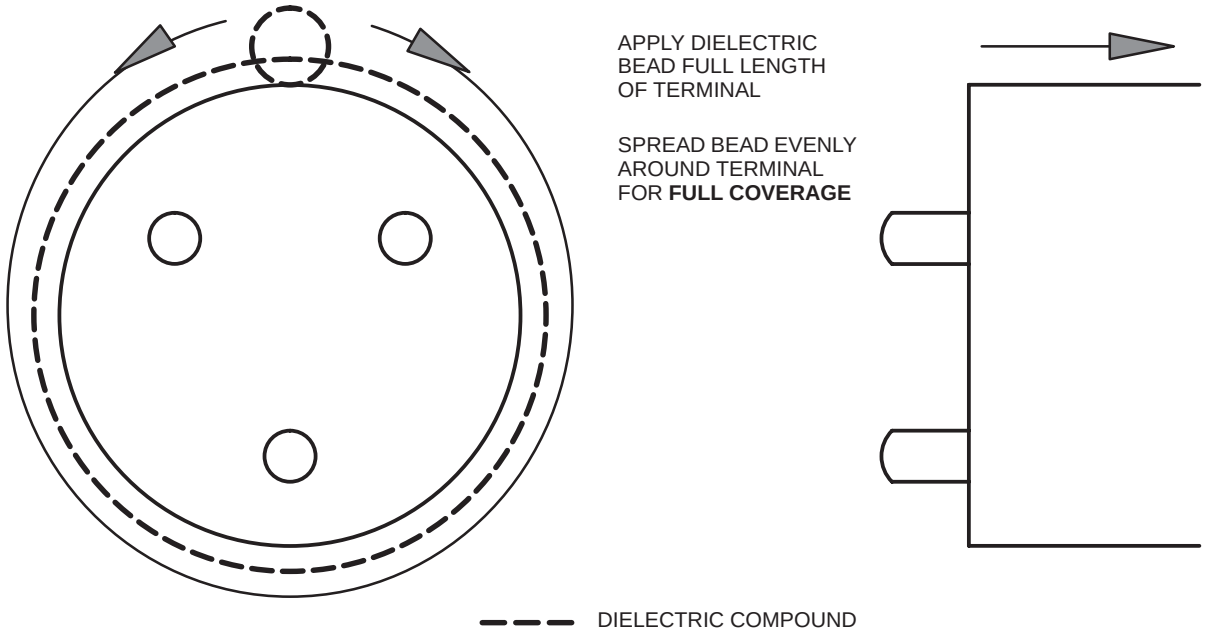
   - If the pins are not scored from localized force fitting and the slot widths are all uniform the cable end and receptacle are compatible and the assembly process can continue.
   - If any pin is scored or the slot width on any pin is not uniform repeat Steps 3 and 4 in an attempt to favorably align the pin and receptacle bushing. This refitting process may be necessary especially with new components.
   - If pin scoring or slot distortion continues, the cable end and receptacle are incompatible and the assembly process cannot continue without corrective action. Establish if the problem is with the cable end or receptacle and replace that component.

SECTION 4
INSERTING CABLES INTO X−RAY TUBES WITHOUT OIL SEALS

1. Place the tapered rubber gasket over the terminal, wide end first, passing the notch in the gasket over the orienting key on the terminal.

2. Apply a bead of silicone insulating compound (46−125224P3) along the cable terminal up to the flared bushing. The bead diameter should be 7 mm minimum. This can be achieved by dispensing the compound directly from the tube without the auxiliary nozzle. Next, spread the compound bead into a thin, uniform circumferential coat around the terminal, working any excess toward the pins. (See Illustration 1).

ILLUSTRATION 1
DIELECTRIC COMPOUND APPLICATION TO SIDE OF HIGH VOLTAGE CABLE


APPLY DIELECTRIC BEAD FULL LENGTH OF TERMINAL
SPREAD BEAD EVENLY AROUND TERMINAL FOR **FULL COVERAGE**
DIELECTRIC COMPOUND

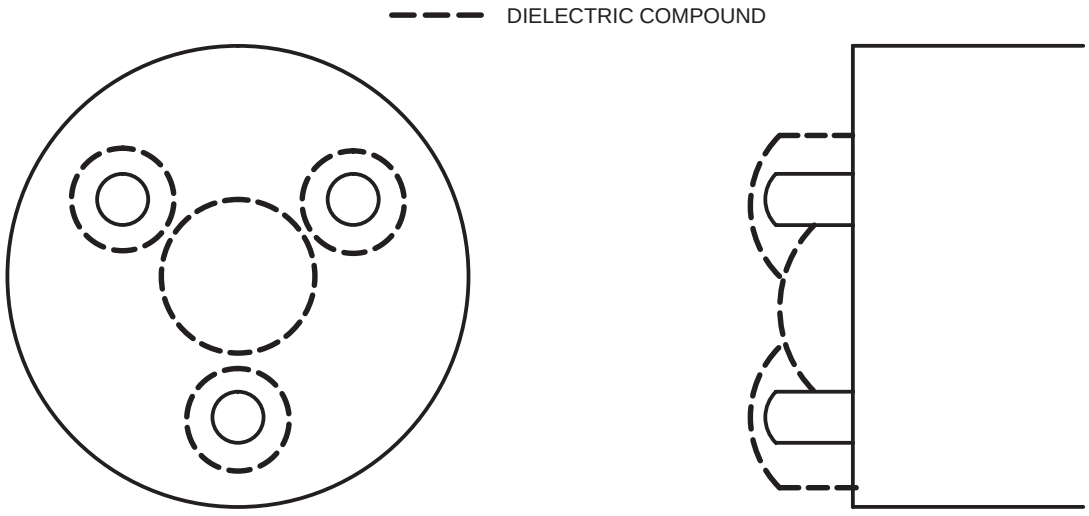
3. Apply compound at the end of the terminal to form a mound nearly as high as the pins. Start at the CENTER and work outward to avoid forming air pockets within the mound (See Illustration 2).

4. Remove the plastic cap from the X−Ray tube cable receptacle. Align the cable terminal orienting key with the notch in the bushing and insert the dressed connector. Keep centered in the receptacle so that no compound is scraped off.

CAUTION

If the cable is pulled outward during the installation process at any time, remove it completely and rework the compound into a dome at the end of the terminal. Remove any compound from the receptacle and add more compound to the cable end, if necessary.

ILLUSTRATION 2
DIELECTRIC COMPOUND APPLICATION TO END OF HIGH VOLTAGE CABLE



5. Maintain steady pressure on the terminal near the bottom of travel to allow the silicone compound on the end of the terminal to creep and fill all of the voids. Use hand pressure until the locking ring can be engaged.

6. Rotate the angled strain relief fitting as required to ensure proper thread engagement and cable orientation. Tighten the locking ring by hand.

7. Begin tightening the ring in a slow manner with cable wrench 46−286957P1 or 507A935G1 for approximately one−half turn. At this point stop and wait approximately ten seconds for the compound to creep and displace air within the joint. Seat the ring to with spanner wrench 46−404295G1 to a torque of 11.1 ± 0.74 NT−M (15 ± 1 ft−lb).

CAUTION

Do not continue to tighten the locking ring once the angled strain relief is secure. Over tightening of the ring will break the receptacle seal and disrupt internal wiring.

8. Loosen the cable locking ring WITHOUT disturbing the cable plug. Retighten the locking ring to 11.1 ± 0.74 NT−M (15 ± 1 ft−lb).

SECTION 5
INSERTING CABLES INTO X−RAY TUBES WITH OIL SEALS OR INTO HIGH VOLTAGE TRANSFORMERS

1. Perform the inspection and preparation processes as indicated in Section 3.

2. Wet the rubber quad ring with transformer oil T0552G and install the ring into the slot at the top of the X−Ray tube receptacle retaining ring. Note that this step DOES NOT apply to the transformer receptacle.

3. Add 15 ml (1/2 oz. or approximately 1 “Caplug”) of transformer oil T0552G into the receptacle. Do not overfill. The resulting depth is approximately 9 mm (.38″).

4. Align the cable terminal orienting key with the notch in the receptacle, keeping it centered. Slowly insert the cable to engage the connector pins and to seat fully. Oil should overflow slightly as insertion is completed showing that all air space is filled. If there is no overflow, the cable is not fully seated or insufficient oil has been used. Withdraw the cable and add oil if necessary.

5. Rotate the angled strain relief fitting as required to ensure proper thread engagement and cable orientation. Engage the locking ring by hand and then begin tightening it in a slow manner with cable wrench 46−286957P1 or 507A935G1. Tighten the ring using spanner 46−404295G1 and a torque wrench to 16.2 ± 0.74 NT−M (22 ± 1 ft−lb). to seat the cable plug.

Do not attempt to continue to tighten the locking ring once the angled strain relief is tight. Over tightening of the ring will break the receptacle seal and disrupt internal wiring.

6. Loosen the cable locking ring WITHOUT disturbing the cable plug. Retighten the locking ring to 16.2 ± 0.74 NT−M (22 ± 1 ft−lb).

FOR X−RAY TUBES

7. Remove residual oil trapped between the rubber quad ring and the locking ring. Temporarily wrap the cable horns with paper toweling and hold in place with tape for approximately 15 minutes. Remove toweling and wipe up any excess oil. Wipe area with a clean towel dampened with cleaning solvent so that the surface is sufficiently clean and dry to permit leakage detection.

SECTION 6
FINAL TIGHTENING AT X−RAY TUBE

After the integrity of the high voltage connection has been verified at the system level in accordance with the defined tube run−in procedure (e.g., Advantx Unit X011) it is necessary to seat the cable ring at an elevated temperature.

- For a new tube unit installation, perform this step during the cooling interval in the run−in and stability procedure.
- For an existing tube unit, perform this step after the housing temperature has been raised to approximately 38° C (100° F).

Loosen the cable locking ring WITHOUT disturbing the cable plug. Retighten the locking ring to 16.2 ± 0.74 NT−M (22 ± 1 ft−lb).

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